Regeneration Programs Section
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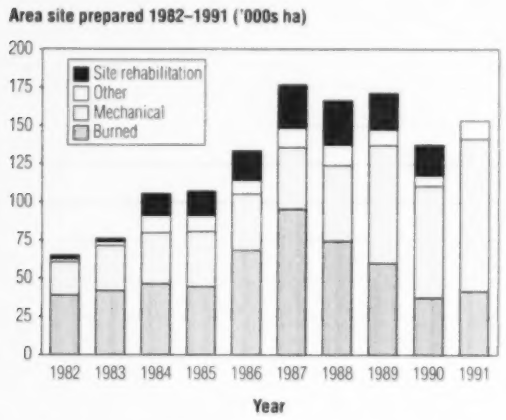
Regeneration Note 5

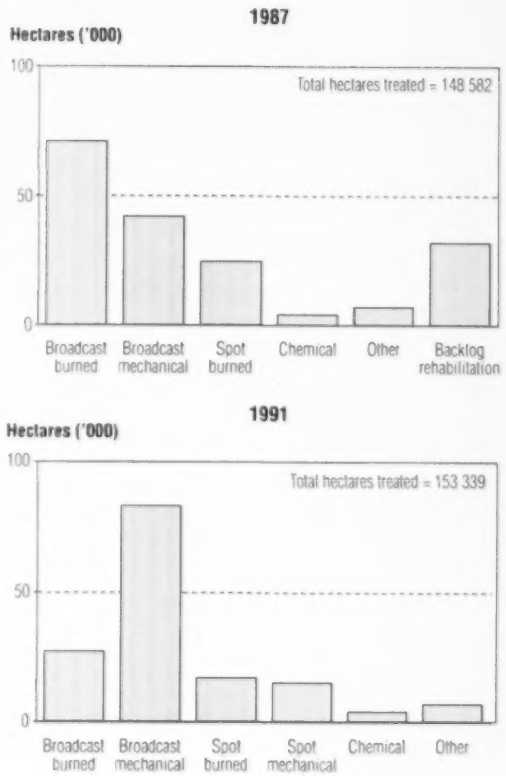
Site Preparation: Microsite Selection and Planting Stock Performance

Site preparation plays a vital role in British Columbia's regeneration program (Figure 1). Historically, prescribed fire has been the tool most commonly used to satisfy the needs of both hazard abatement and site preparation. Recently, the use of fire has decreased relative to other options (Figure 2), due to the increased cost of burning, the increased public concern in areas sensitive to smoke, changes in the policy regulating burning, and a significant increase in viable treatment alternatives. An increased mechanical site preparation (MSP) program combined with the introduction of specialized site preparation



Note: Beginning in 1991, site rehabilitation is no longer recorded by the Ministry of Forests under a separate category.

Figure 1. Site preparation has increased overall, while prescribed burning has given way to mechanical site preparation.



Note: Backlog rehabilitation not broken out for 1991.

Figure 2. The use of burning as a tool for site preparation decreased significantly between 1987 and 1991.

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equipment has made it possible and often desirable to "tailor-make" microsites on a site-specific basis.

This regeneration note will investigate two mechanical site preparation treatments common in B.C., namely disc trenching and mounding. The various microsites associated with these treatments will be discussed in detail. Many of the principles outlined in this report can be extrapolated to other MSP treatments.

Disc Trenching

One of the more popular forms of mechanical site preparation in B.C. is powered disc trenching. Approximately 30,000 hectares were prepared for planting by this method in 1992. Disc trenchers employ rotating discs with downward pressure to produce two parallel trenches that create a mixed mineral and organic side cast. After disc trenching, several planting positions (microsites) are available to the planter. Each microsite has unique characteristics that should be considered by the forest manager. Three general microsites will be considered in this paper; the berm, the hinge and the trench (Figure 3).

The concepts presented here are not limited to disc trenching but may be applied equally to other linear treatments such as the ripper plow and Marttiini plow.

Figure 3. Seedlings planted on the berm, on the hinge, and in the trench.

The Berm

General comments

The berm may produce different effects than expected. Often the surface of a disc trench berm is equated with the mineral capping on a mound. However, the mineral capping on a mound tends to be quite dense and is a relatively good conductor of heat, which is easily transmitted into the mound. In contrast, when the berm of a disc trencher is first formed it tends to be much looser than the cap on a mound and for the first few years, or until the berm settles, may actually act as a mulch. This means that the humus below the berm may remain somewhat cooler and moister than would be expected.

Advantages of planting on the berm

- The berm is the microsite of choice for wet sites.
- If the berm has a high component of well decomposed organic material and the site is reasonably wet, the risk of drought on the berm is minimal and the increased elevation decreases the risk of flooding.

It must be noted that for very wet sites, even when seedlings are planted on the berm, disc trenching is not as effective as mounding.

Disadvantages of planting on the berm

- On sites where the berm is cast on top of debris, where coarse woody debris is incorporated into the berm, or where much of the berm consists of loose, undecomposed humus (Mor type), there is a high risk of drought, particularly on mesic and drier sites. On such sites the berm is not an appropriate planting site.
- Trees planted on the berm will be somewhat more exposed than trees planted lower on the profile. This may have some implications for young seedlings planted in areas affected by severe winter conditions.

The Hinge

General Comments

The relationship between the hinge position and vegetation is worthy of mention. The hinge position provides an excellent medium for root extension. Roots that are severed by the discs will often sprout, then extend rapidly along the hinge of the trench. Common examples of species that adopt this strategy are fireweed (*Epilobium angustifolium*) and aspen (*Populus tremuloides*). Disc trenching may provide the opportunity for aspen to spread quickly across a site. If this is a concern, intermittent trenches should be employed as a mechanism to retard the spread of aspen.

Advantages of planting on the hinge

- The microsite located high on the hinge often provides the optimum compromise between the berm and trench and, as such, is commonly the microsite of choice for sites in the boreal forest.

- Care should be taken to plant seedlings high enough on the hinge to ensure that root systems are surrounded by organic matter. This decreases the potential for frost heaving and increases the amount of nutrients available to the seedling.

Disadvantages of planting on the hinge

- Planters tend to plant too low on the hinge, introducing the negative qualities associated with the trench position.
- Snow may slip off the berm and cause seedlings planted on the hinge to bend or break. The highest risk is in the spring when the snow on top of the berm thaws and then freezes, forming a heavy mass with an icy surface. This material then slips down into the trench. Usually the difference in height between the berm and hinge is minimal, and snow movement from the berm to the trench is of little consequence provided seedlings have sufficient caliper.

The Trench

General Comments

The trench is a preferred planting position on some drier sites in southern B.C. However, it is rarely the preferred microsite in northern B.C., particularly on sites with moist/wet fine-textured soils.

Although the trench is not often the preferred planting microsite in northern B.C., trench profile should still be closely monitored by the forest manager because it may affect future performance of seedlings planted on adjacent microsites. On some sites, roots from seedlings planted on the berm/hinge have no problem crossing a shallow trench. However, if the trench is too deep and exposes a particularly unfavourable substrate (e.g., Bt soil horizon, high water table, compacted horizon), roots may be prevented from crossing the trench. A good rule of thumb is, if the natural rooting depth of native vegetation is restricted by an unfavourable substrate, keep the trench depth above the restricting substrate—do not go below the predominant rooting depth of vegetation on the site.

Advantages of planting in the trench

- Trench planting usually increases availability of water in areas prone to drought.
- Planting in this position means there is less exposure to winter damage.

However, the trench is not usually a preferred microsite in northern B.C., particularly in the Peace River region.

Disadvantages of planting in the trench

- Animals, domestic and wild, tend to walk down trenches, and thereby damage seedlings by trampling and occasionally by browsing.
- Nutrient rich organic material is removed during trenching, so the microsite often proves to be a poor source of nutrients.
- The trench is a particularly harsh environment in dense, fine-textured soils on moist to wet sites. On such sites, seedlings planted in the trench are susceptible to frost heaving as well as flooding (in the spring or after sustained rainfall). Where these sites do dry out, trenches become extremely hard, inhibiting root penetration.

Trench Orientation

The direction travelled by the prime mover will determine trench orientation and the aspect of the trench profile. For example, when the prime mover is travelling north/south, trenches will also run north/south and trench profiles will have an east and west aspect (Figure 4). It has been suggested that "in the north," seedlings planted on trenches that run north/south will outperform seedlings planted on trenches which run east/west. This theory has been borne out on microsite planting trials located in the vicinity of Prince George. At one trial, located on a mesic site adjacent to Bednesti Lake, it was found that five years after planting, pine seedlings on the hinge of north/south oriented trenches were approximately five per cent taller than seedlings planted on the hinge of east/west oriented trenches. It was interesting to observe at this trial that, as predicted, seedlings planted on the south aspect outperformed seedlings planted on the north aspect. However, contrary to the pre-trial hypothesis, seedlings planted on the east aspect outperformed seedlings planted on the west aspect, demonstrating the importance of early morning sun.

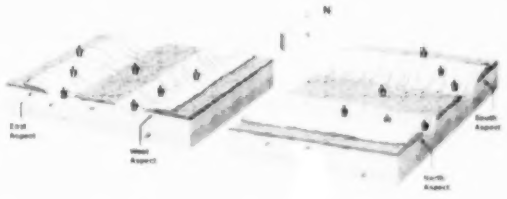

Figure 4. Diagram showing how direction and aspect of the trench vary depending on the direction in which the prime mover is travelling.

The actual difference in seedling performance associated with trench orientation varies by site.

When determining the most appropriate trench orientation, the forest manager must also consider other operational factors, such as length of pass for the site preparation contractor, planter access, and potential for erosion. In many cases these and other operational factors will override the potential benefits of the north/south trench orientation.

Operational tip

When disc trenching, if the prime mover moves in a north/south direction, a trench will be created that runs north/south, creating profiles that have an east/west aspect. This is usually ideal. In contrast, when undertaking spot scarification (e.g., using the Bräcke), a prime mover moving in a north/south direction will create patch/mound profiles with north/south aspects. This is not ideal. For spot scarification, where other factors are not significant, the prime mover should travel east/west rather than north/south.

Creating the Microsite—Operational Considerations

If disc trenching is poorly implemented, micro-sites may be inadequate to address site limiting conditions. When trenching a site, the following factors may affect trench quality and should be considered.

➤ **Problem**: A poor prescription or poor communication with the site preparation operator can result in an inappropriate treatment.

Solution: Know what you want and clearly communicate this to your operator.

➤ **Problem**: Inappropriate use of equipment or not matching equipment settings to site conditions can lead to inappropriate treatments. For example, if a machine is travelling too fast and the disc angle is too wide, the humus-to-mineral soil ratio in the berm will be too high and the berm will tend to be cast away from the trench.

Solution: At the onset of operations, try a range of settings to determine the appropriate trencher setting (disc angle, down pressure and rotation speed) and speed for the prime mover. On some sites, an excellent profile can be created with the prime mover moving relatively quickly, with little down pressure and a relatively wide disc angle (e.g., on a sandy site with thin humus). On other sites a compromise will be required to obtain the appropriate profile; for example, on a grassy site where "sod" overlies a relatively compacted, fine-textured soil, an acute angle, high down pressure and slow prime mover speed are required to provide adequate penetration to create a good profile. However, if the angle is too acute and the speed of the prime mover is too slow, sod will tend to fall back into the trench and discs will also tend to become clogged. In this case, a compromise is required—moderate speed and moderate disc angle.

➤ **Problem**: There may be too much slash on site for discs to penetrate.

Solution: If slash is reasonably light, a V blade can be attached to the prime mover and trenching can still be done in a single pass. In this instance, use the V blade to realign the slash ahead of the prime mover. If slash loading is moderate, a crawler tractor may be used rather than a skidder (the forwarder has not been used for disc trenching in B.C., so it is not discussed here). If slash loading is very heavy, it may be necessary to adopt a two-pass system, where the slash is dealt with prior to trenching. If this is not feasible, consider a different treatment, such as excavator scarification/mounding.

➤ **Problem**: The humus may be too thick, preventing discs from reaching mineral soil. This will result in a berm that does not have an optimum mineral soil/humus mix.

Solution: Check the prescription. If humus is too thick, a different treatment (such as mounding) may be more appropriate. If the prescription is appropriate, try adjusting the trenching equipment (e.g., disc angle, down pressure, speed of prime mover). If the profile is still unacceptable, a second pass can be made over the same ground. This is called "double discing," where the first pass will remove some of the debris and a portion of the humus and the second pass will penetrate more deeply, incorporating more mineral soil into the profile. Another option is to use a V blade to align the slash and upper portion of the humus.

➤ **Problem**: On some sites mineral soil may be difficult to penetrate (e.g., dry fine-textured soils or rocky sites).

Solution: If fine-textured soils are trenched when moist, soil resistance is much lower and it is easier to obtain the penetration necessary to create the desired profile. However, moist soils are more prone to rutting, so caution should be exercised. Not much can be done about rock.

► **Problem**: Disc trenching on snow or frozen ground may not provide an acceptable profile. Often the berm appears to be acceptable (i.e., well mixed, adjacent to the hinge, good profile), but when the snow melts the berm is often smaller than expected. Further, there is often a space between the berm and the trench, eliminating the "normal" hinge position.

Solution: If possible, schedule treatments so that trenching does not have to be undertaken when frost or snow will interfere with job quality. Where jobs have to be completed with frost in the ground, double discing will produce an acceptable profile if frost is not too deep. When trenching on snow, carefully monitor the depth of the trench to ensure that discs are picking up sufficient mineral soil for the berm, and avoid trenching when snow gets too deep.

Summary Statement for Disc Trenching

Advantages

- Disc trenching is a relatively inexpensive treatment that provides a range of microsites.
- The treatment facilitates good planting and is often the MSP treatment of choice for planters.

Disadvantages

- Disc trenching is restricted on steep slopes (i.e., greater than 35%) and on sites with very heavy slash, particularly if stumps are high and closely spaced.
- Disc trenching is not appropriate for all sites (e.g., it is inappropriate for very wet sites, or sites with potential for excessive vegetation unless secondary vegetation control is planned).
- The straight rows associated with this treatment may result in a highly "structured" forest. This may not be preferred in some areas.
- Continuous trenches may also increase damage from both domestic and wild animals.
- If not properly managed, trenches may contribute to erosion.

General Comments

Disc trenching can provide a range of potential microsites. At the prescription stage, the forest manager should determine the microsite that is most appropriate for the site, and prescribe a treatment that will provide an adequate number of the preferred microsites. The prescription should be carried through to the field level with good communication and monitoring.

On some sites, the difference in seedling performance associated with microsite can be dramatic. At Tanli Lake, located in the Vanderhoof Forest District of the Prince George Forest Region, a lateral distance of approximately 20 cm (hinge vs trench) has had a dramatic effect on short-term seedling performance (Figure 5).

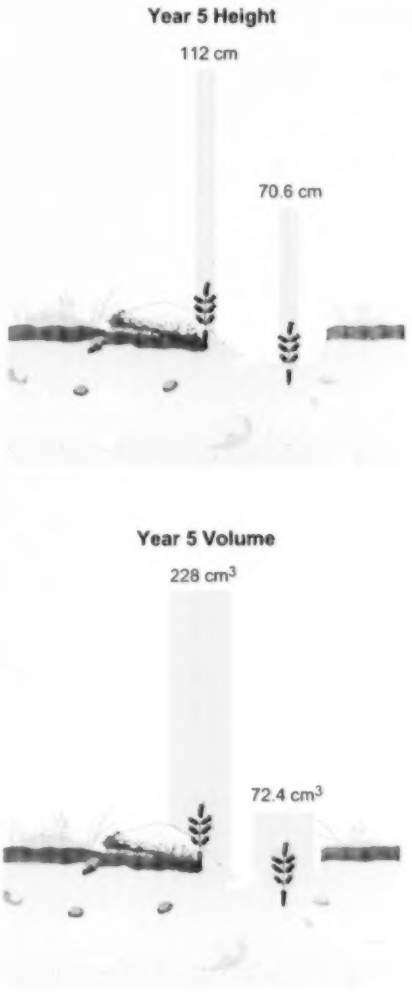

Figure 5. Height and volume performance of trench- and hinge-planted seedlings by year 5 at Tanli Lake.

Mounding

Mounding plays a valuable role in forest establishment in B.C. Raised spots created by mounding have improved drainage and aeration on wet sites, and warm more quickly than untreated ground.

The potential for mounding as a tool for reforestation has been recognized for a long time. In England, Pontey [1808] recommended treating shallow clay soils by drawing soil to the base of trees to increase rooting depth. In B.C., mounding research trials were established in the late 1970s and seedling performance has been carefully monitored.

In B.C., most mounding is done with excavators. The Bräcke mounder is used to a limited extent and the B.C. Mounder prototype is undergoing operational testing in B.C. and Alberta. A Donaren 870 mounder, mounted on an 8-wheel forwarder, was operationally tested in B.C. this past summer. This paper examines mound construction, mound size, mound form, vegetation control and planting microsites associated with the mound.

Mound Construction

Mounds can be constructed in at least four ways:

1. Placing mineral soil directly on the undisturbed forest floor. This technique is often used in combination with drainage.
2. Inverting the forest floor and placing a mineral soil cap on top of the inverted material. This type of mound is commonly prescribed in B.C.
3. Mixing the mineral soil and forest floor, then raising the material to form a mixed mound. Two excavator attachments have recently been developed for creating mixed mounds—the VH mulcher and the Hytest Tiller.
4. Removing the forest floor and placing mineral soil directly on mineral soil (i.e., creating a mound of pure mineral soil). This technique has been successful on cold, relatively dry sites in Sweden. However, experience in the Peace River region of B.C. has been very discouraging. On Peace River sites, the humus within a mound was found to be critical for good seedling performance.

In general terms, the mound should not be separated from the scalp. Ideally, there should be a mineral soil profile created that runs continuously from the scalp up onto the mound. The mound should be relatively flat on top and the sides of the mound should not be vertical.

Detailed information on the various "mound types" is available from other sources, and will not be discussed here.

Mound Size

Advantages of large mounds

- Large mounds are preferred to small mounds on sites where vegetation has the potential to severely compete with planted seedlings, or on backlog sites where aggressive vegetation is well established prior to treatment.
- In areas where it is predicted that mounds will settle, a larger mound will compensate for settling. Mounds tend to settle more where there is vegetation or small debris under the mounds, when the mounds are constructed of loose, coarser-textured material, and in areas of high snow fall.
- In areas where there is light debris remaining on the ground, large mounds tend to push down the debris, reducing the chance of air pockets forming under the mound. Large mounds, however, cannot compensate for heavy debris.
- On steep slopes with heavy snow fall, large mounds can reduce damage from snow creep.
- Large mounds can reduce trampling damage from cattle. Also, rabbit damage has been observed to decrease in areas with large mounds.
- Large mounds may be more effective in reducing frost damage.

Disadvantages of large mounds

- Creating large mounds is usually more expensive than creating small mounds, requiring the use of an excavator as opposed to a Donaren 870 or a Bräcke.
- Large mounds create more soil disturbance than small mounds. There is also the potential to make mounds larger than required. This may cause further soil disturbance, increase planting difficulty, and negatively affect seedling performance.

For many sites, particularly if site preparation is completed immediately following harvest, a small mound is adequate to achieve treatment goals.

Generally speaking, even where a large mound is required, there is little advantage to constructing a mound with a diameter greater than 100 cm and a height greater than 30–40 cm after planting. There are exceptions, however (e.g., in very wet areas where a limited number of mounds will be constructed and each of these will form a "mini bed," where more than one tree will be planted per mound).

Mound Capping

The capping on top of a mound is important for vegetation control and for regulating the temperature/moisture relationship within a mound. The effect of mound capping on vegetation control will be discussed in the vegetation control section.

There is usually little advantage to creating a mineral soil cap that exceeds 15 cm in depth. This is particularly true for fine-textured soils.

Preliminary results from a nine-year-old mounding trial located in the Peace River region, in the vicinity of Wonowon on the Alaska Highway, confirmed this. Seedlings planted on mounds with six cm of mineral capping did not perform as well as seedlings planted on mounds with a 15 or 20 cm capping. However, there was no difference in performance between seedlings planted on mounds with either 15 or 20 cm of mineral soil capping.

It is interesting to note that mounds capped with fine-textured mineral soil may actually dry out more than mounds capped with sand. That is, the surface of the mound capped with sand dries very quickly, forming a mulch, preventing loss of moisture from within the mound. Also, the fine-textured mineral soil capping has a low saturated hydraulic conductivity and may shed moisture, or allow it to evaporate rather than be transported down into the mound.

Mounding and Vegetation Control

Large mounds are more effective than small mounds in areas of dense herbaceous vegetation. A large mound tends to raise the seedling above the surrounding vegetation and also slows the development of vegetation adjacent to the base of the seedling.

The effectiveness of a mound in controlling competing vegetation depends on the species of vegetation and on seral development. Well established vegetation complexes (e.g., backlog sites) are usually more difficult to control than areas where harvesting has just been completed. Species also have different competitive strategies (e.g., fireweed will tend to seed in on top of a mound, whereas bluejoint [*Calamagrostis canadensis*] will grow up beside the mound and overtop it). On sites where fireweed is particularly thrifty it can seed on top of the mound and also overtop the mound from the sides.

Capping material and capping depth influences vegetation control. Humus enriched capping does not prevent encroachment of vegetation as effectively as an infertile cap (e.g., the Bt of a luvisol will hold back vegetation very well). Mounds with a very shallow mineral soil cap will not prevent suckering of vegetation from within the mound.

The season when a mound is constructed may influence the kind and extent of revegetation on it. For example, if an area is mounded during the dispersal of fireweed seed, the seed will land on a very hospitable seedbed and will germinate the next spring. In contrast, if the mound is made after seed dispersal is complete, the seed will not have an opportunity to colonize the mound until seed dispersal the following fall. By this time, the cap of the mound will be somewhat more inhospitable and seedlings planted in the spring will be well established on the mounds.

It is also important to consider how the mound affects the vigor of the seedling. If the vigor of seedlings planted on mounds is significantly enhanced, the seedling will be better able to withstand vegetative competition.

On sites where it is predicted that mounds will not be able to adequately control vegetation, it may be possible to prevent the establishment of aggressive competing vegetation by seeding a more preferred species on the mound. Research on "replacement vegetation" is ongoing.

Selecting the Microsite

When planting the mound, the seedling can be placed on top of the mound or on the hinge.

Planting on top of the mound

Advantages

- Seedlings planted on the tops of mounds are removed, as far as possible, from competing vegetation.
- Seedlings planted on top are less prone to flooding.
- In spring, seedlings get off to a quick start, as snow melts off the mound first, allowing the soils to be warmed.

Disadvantages

- Seedlings planted on the top of mounds are more likely to lose their snow cover and be exposed by a chinook, for example. In this situation, seedlings are more susceptible to winter damage. This has been observed in the Peace River region of B.C.
- Seedlings that get off to a quick start in spring may be more susceptible to early spring frost. However, this has not proved to be a significant problem in B.C.

- If mounds are not properly formed or if seedlings are not properly planted, there is an increased incidence of toppling compared to untreated ground. This is particularly true for pine.

Planting on the hinge

Advantages

- Seedlings planted on the hinge position are exposed less to winter extremes in areas where snowfall is low or Chinooks are common.
- On mounds with a very deep mineral soil cap, it is often easier to ensure that the seedling's root system is in contact with humus, if it is planted off the top of the mound.

Disadvantages

- Snow from the top of the mound can slide off and bend a seedling planted on the hinge. This problem is accentuated in the spring when the snow melts, then freezes, forming a wet, heavy cap of snow with a frozen surface capable of sliding down over the seedling.
- If the hinge position consists of mineral soil over mineral soil and the soil texture is quite fine, there is an increased risk of frost heaving on the hinge position. In addition, seedlings planted on the hinge are closer to competing vegetation.

Planting the mound

In B.C., seedlings are generally planted on top of the mound. When this planting position is prescribed, the planter should be made aware of the following points:

1. Seedlings should be planted deeply—deeper than the root collar. There are several reasons for deep planting:
   - ~ mounds tend to settle and erode over time, exposing shallow root systems,
   - ~ the surface of the mound will dry out, causing a moisture deficit for roots located near the surface,
   - ~ it is often necessary to plant deep to ensure that part of the root system is in the humus, and
   - ~ a tree that is planted deeply, with its root system into the humus, is less prone to frost heaving.
2. A seedling's root system should not be confined to the mineral cap; instead, it should extend into the humus. This is particularly true in fine-textured soils.
3. When planting the top of a mound there is a tendency to "J root" the seedling at the bottom of the mineral cap rather than having it enter the inverted humus as it should. "J" planted seedlings on a mound have an increased risk of toppling and of drying out, and may have root systems confined to the infertile cap rather than reaching down into the moist/fertile humus.

Conclusion

With the introduction of specialized site preparation equipment it is possible and often desirable to "tailor-make" microsites on a site specific basis. Identifying limiting site factors, determining the most desirable microsite to offset these limiting factors and implementing a site preparation program to create these microsites is often complicated and time-consuming. When properly managed, however, the returns can be great and they can play a crucial role in a successful regeneration program.

Reprinted from a paper prepared by Lorne Bedford and Marc von der Gönna, Silviculture Branch, presented at the Symposium on Planting Stock Performance and its Relationship with Site and Microsite, Athabasca, AB, September 1993.

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